Compositional Evolution of Saturn's Rings: Ice, Tholin, and "Chiron"-dust

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We address compositional evolution in planetary ring systems subsequent to meteoroid bombardment. The huge surface area to mass ratio of planetary rings ensures the importance of this process, given currently expected values of meteoroid flux. We developed a model which includes both direct deposition of extrinsic meteoritic "pollutants", and ballistic transport of the increasingly polluted ring material as impact ejecta. Certain aspects of the observed regional variations in ring color and albedo can be understood in terms of such a process.

We conclude that the regional scale color and albedo differences between the C ring and B ring can be understood if all ring material began with the same composition (primarily water ice, based on other data, but colored by tiny amounts of non-icy, reddish absorber) and then evolved entirely by addition and mixing of extrinsic, neutrally colored, highly absorbing material. This conclusion is readily extended to the Cassini Division and its surroundings as well. Typical silicates are unable to satisfy the ring color, spectroscopic, and microwave absorption constraints either as intrinsic or extrinsic nonicy constituents. However, "Titan Tholin" provides a satisfactory match for the inferred refractive indices of the "pre-pollution" nonicy ring material. The extrinsic bombarding material is compatible with the properties of Halley or Chiron, but not with the properties of other "red" primitive objects such as Pholus.

We further demonstrate that the detailed radial profile of color across the abrupt B ring - C ring boundary is quite compatible with such a "pollution transport" process, and that the shape of the profile can constrain key parameters in the model. We use the model to estimate the "exposure age" of Saturn's rings to extrinsic meteoroid flux. We obtain a geologically young "age" which is compatible with timescales estimated independently based on the evolution of ring *structure* due to ballistic transport, and also with other "short timescales" estimated on the grounds of gravitational torques.

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